

**BICRON ♦ NE**

6801 Cochran Road

Solon, Ohio 44139

Telephone: (216) 248-7400

(800) 472-5656

Telefax: (216) 349-6581



**ANALYST Portable Analyzer  
with Digital Scaler Option**

**User's Manual**

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## FOREWORD

This manual provides the basic installation, operation, and maintenance procedures for the Bicron ANALYST Portable Analyzer with Digital Scaler Option.

**Section 1.0 Introduction** provides a general description of the instrument and its operation, and a detailed listing of its physical and performance specifications.

**Section 2.0 Battery Installation** describes the procedure for changing the battery and checking its performance.

**Section 3.0 Single Channel Analyzer Operational Modes** describes three different modes in which the instrument may be operated.

**Section 4.0 Setup** describes the setup procedures for a number of the instrument's operational options.

**Section 5.0 Digital Scaler** describes the features and operation of the optional Digital Scaler.

**Section 6.0 Audio** describes the operation of the instrument's audio warning feature.

**Section 7.0 Selectable Response Time** describes the operation of the Response Time Selector switch.

**Section 8.0 Operation** provides a detailed description of the operation of the ANALYST, including the necessary procedures for each of the available probe types.

**Section 9.0 Circuit Description** provides a brief description of the four electronic circuits that make up the instrument.

**Section 10.0 Calibration** provides directions for calibration of the instrument.

The **Appendices** are: A) QC Acceptance Procedure which includes calibration procedures, B) a complete spare parts list so instruments can be repaired on-site, and C) schematic and pictorial diagrams to facilitate repair procedures.

## Safety Warnings

In order to maintain consistency throughout this and all BICRON ♦ NE manuals, certain writing conventions have been followed for safety warnings. They are divided into three categories and defined as follows:

- **DANGER** indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. ***DANGER NOTICES ALWAYS APPEAR IN BOLD, ITALICIZED UPPER CASE LETTERS.***
- **WARNING** indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury. ***WARNING NOTICES ALWAYS APPEAR IN UPPERCASE BOLD LETTERS.***
- **CAUTION** indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices. ***CAUTION notices always appear in bold, italicized letters.***

The definition of these safety warnings is according to ANSI Z535.4. The style of

**FOREWORD (cont'd)**

the warnings (bold, italicized, etc) is BICRON ♦ NE's.

In addition to the above, we have added the following warning:

- NOTE indicates a situation which has the potential for erroneous data collection or damage to equipment, but

which does not directly affect the safety of the operator with respect to this product. The responsibility for any safety consequences as a result of erroneous data lies solely with the operator. *NOTE notices always appear in italics.*

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**BICRON ♦ NE WARRANTY STATEMENT  
COVERING PORTABLE MONITORS**

Instruments and options manufactured by BICRON ♦ NE are warranted against defects in materials and workmanship for a period of two years from the date of shipment, unless otherwise agreed upon by BICRON ♦ NE and the customer in writing.

BICRON ♦ NE's obligation with regard to such products shall be limited to repair or replacement FOB BICRON ♦ NE factory or authorized repair station, at BICRON ♦ NE's option.

The calibration (when applicable) for each system is warranted to be within its specified accuracy at the time of shipment. If this initial calibration is determined to be in error, the system will be recalibrated at no charge.

The aforesaid warranty does not cover systems, options or probes which are subject to excessive physical abuse or are used for purposes other than those intended. In no event shall BICRON ♦ NE be liable for consequential or special damages, transportation, installation, adjustment, work done by customer, or other expenses which may arise in connection with such defective product or parts.

**EXCLUSION OF LIMITED WARRANTY**

THERE ARE NO WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS, WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF. THIS EXPRESS WARRANTY EXCLUDES COVERAGE OF, AND DOES NOT PROVIDE RELIEF FOR, INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY KIND OR NATURE, INCLUDING, BUT NOT LIMITED TO, LOSS OF USE, LOSS OF SALES OR INCONVENIENCE. THE EXCLUSIVE REMEDY OF THE PURCHASER IS LIMITED TO REPAIR, RECALIBRATION, OR REPLACEMENT OF THE SYSTEM AT BICRON ♦ NE's OPTION.

This warranty specifically excludes the following items which are covered by their original manufacturers' warranties: photomultiplier tubes, GM and proportional tubes, crystal and other solid-state detectors and batteries.

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User's Manual

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**PROCEDURES and CAUTIONS**

The equipment herein described is designed and manufactured in compliance with all applicable safety standards. Nevertheless, certain hazards are inherent in the use of electronic and radiometric equipment.

Adequate warnings are included in the manual and on the product itself to cover hazards that may be encountered in normal use and servicing of this equipment. No other procedures are warranted by Bicron.

It shall be the owner's or user's responsibility to ensure that the procedures and cautionary notes are heeded.

Failure on the part of the user in any way to follow the prescribed procedures shall absolve Bicron and its agents from any resulting liability.

This instrument is intended solely for the detection and measurement of ionizing radiation. It should be used only by persons who have been trained in the proper interpretation of its readings and the appropriate safety procedures that should be followed in the presence of radiation.

All instructions and warnings contained in this manual or on the instrument must be read before use and must be strictly followed. Failure to follow these instructions and warnings may result in inaccurate readings and/or user hazard.

Indicated battery and other operations tests must be performed prior to each use to assure that the instrument is functioning properly.

**WARNING**

**FAILURE TO CONDUCT PERIODIC PERFORMANCE TESTS IN ACCORDANCE WITH ANSI N323-1978, PARAGRAPHS 4.6 AND 5.4, AND TO KEEP RECORDS THEREOF IN ACCORDANCE WITH PARAGRAPH 4.5 OF THE SAME STANDARD, COULD RESULT IN ERRONEOUS READING OR POTENTIAL DANGER. ANSI N323-1978 BECOMES, BY THIS REFERENCE, A PART OF THIS OPERATING PROCEDURE.**

**INSPECTION**

Instruments should be examined and tested as soon as received. Claims for transportation damages, if any, should be filed at once with the delivery carrier.



## 1.0 Introduction

### 1.1 General Description

The Bicron Analyst with Digital Scaler Option is a versatile, portable, count-rate meter designed to be used with scintillation or GM probes for the detection and measurement of ionizing radiation. Its single-channel analyzer with three modes of operation also permits energy discrimination and significant background reduction. An optional built-in digital scaler provides counting times of 0.1, 1, and 10 minutes.

The instrument features a recessed meter movement, laminated control panel, cpm and KV meter scales, single on-off/range selector switch, MHV probe connector and mounted probe holder.

Advanced circuit design provides adjustable detector high voltage with readout on the meter, three-mode single channel analyzer providing two distinct areas of interest, resolving time compensation for linear response with scintillation probes, switch selectable response time optimized for each range, and built-in audio.

### 1.2 Specifications

**Radiation Detected:** Alpha, beta, gamma, X-ray, neutron depending upon detector used.

**Range:** Four linear ranges of 0-500, 0-5,000, 0-50,000, and 0-500,000 CPM.

**Accuracy:** Within 10% of reading between 20% and 100% of full scale on any range.

**Detector:** Choice of GM and scintillation probes.

**High Voltage:** Electronically stabilized, adjustable to at least 1600V (typically 2000V) with read-out on the meter; high voltage can support a 100-megohm load.

**Connector:** MHV.

**Warmup Time:** None.

**Single Channel Analyzer Modes:** Selected by front-panel control as follows:

**ch. 1:** Accepts signals within the analyzer window only.

**ch. 2:** Accepts signals above the analyzer window only.

**out:** Accepts all signals above the lower-level discriminator.

**Lower-level Discriminator:** Adjustable from less than 0.1 to 1 volt with internal potentiometer.

**Window:** Adjustable from 0 to 1 volt above the lower-level discriminator setting with internal potentiometer.

**Pulse-pair Resolution:** Typically 10 micro-seconds or less.

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**1.0 Introduction (cont'd)****1.2 Specifications (cont'd)**

**Response Time:** Switch-selectable, optimized for each range, 0-90% of final reading, as follows:

Range	Time	
	Fast	Slow
X1	12 sec.	20 sec.
X10	1 sec.	8 sec.
X100	<1 sec.	2 sec.
X1000	<1 sec.	1 sec.

**Temperature:** Operational from -20°C to 50°C.

**Humidity:** Less than 5% change in reading from 10-95% relative humidity.

**CONTROL:** Seven-position rotary switch: "off", "bat.", "HV", "X1000", "X100", "X10", "X1" (Figure 1).

**Battery Complement:** Single 9-Volt (MN1604 or equal). The additional battery holder may be used for storage of spare or parallel-wired.

**Battery Life:** Typically 100 hours (200 hours with parallel option) for GM probes in normal background, and 50 hours (100 hours with parallel option) for scintillation probes; use of audio may reduce battery life.

**Display:** Ruggedized, recessed, high-torque 1 mA

meter with 3.35-inch scale marked 0-500 counts per minute and 0-2.0 kilovolts, with 'bat ok', checkband. Meter protected by impact-resistant Lexan<sup>R</sup> polycarbonate window (Figure 2).

**Geotropism:** Within  $\pm 2\%$  of full scale.

**Shock:** 100g per lightweight machine of MIL-STD 202C, method 202B.

**Vibration:** 5g in each of three mutually orthogonal axes at one or more frequencies from 10-33Hz.

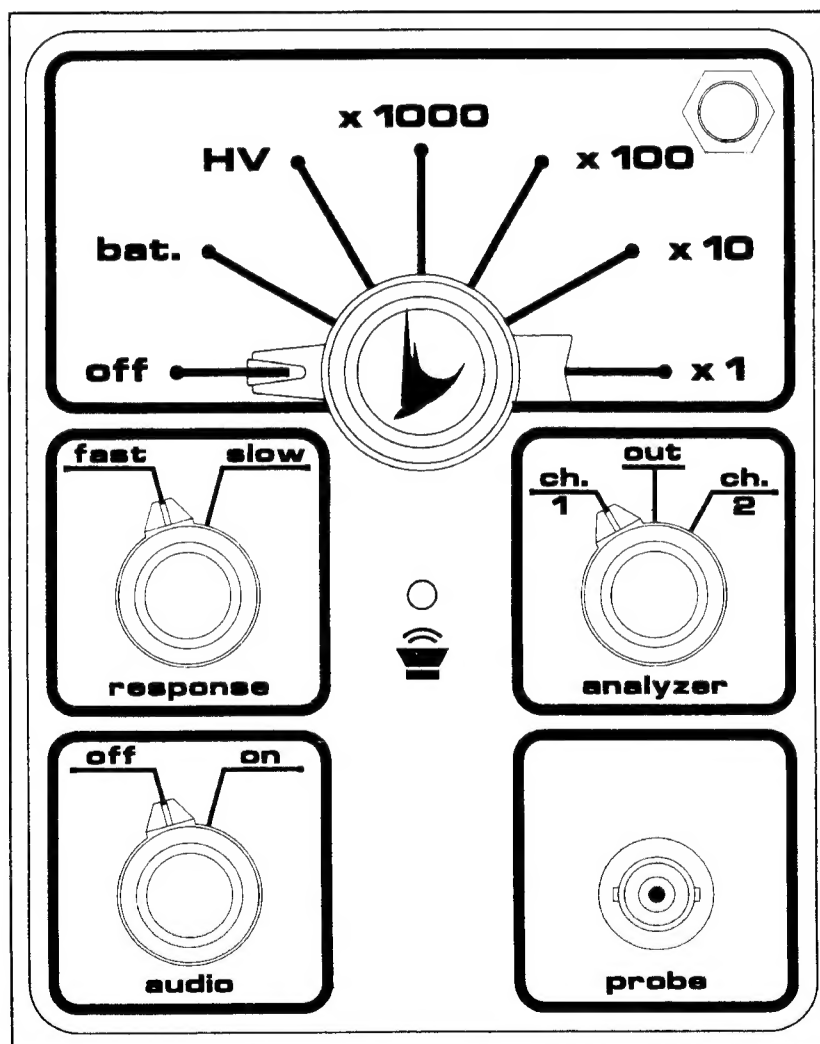


Figure 1  
External Controls

## User's Manual

## 1.0 Introduction (cont'd)

## 1.2 Specifications (cont'd)

**Construction:** Splash-proof, shockproof, two-piece all-metal case; scratch-resistant, laminated control panel and Bicron Kleen-Krome<sup>R</sup> trim on case top; durable black polyurethane paint used on handle and case bottom; stainless steel probe clip.

**Audio:** A built-in speaker (with panel mounted on-off switch) provides audible "click" for each detector pulse. With the speaker off, an audible alarm sounds (if

desired) when meter is greater than full scale on any range.

**Scaler:** 6-digit, 0.2-inch-high liquid crystal display with three internally set time periods: 0.1, 1.0, and 10 minutes. Timebase is crystal-controlled with an accuracy greater than 0.1%.

**Size:** 10.8cm X 20.3cm X 17.3cm (4.25" X 8" X 6.8") including handle and probe clip.

**Weight:** 1 kg. (2.2 lbs.), excluding probe.

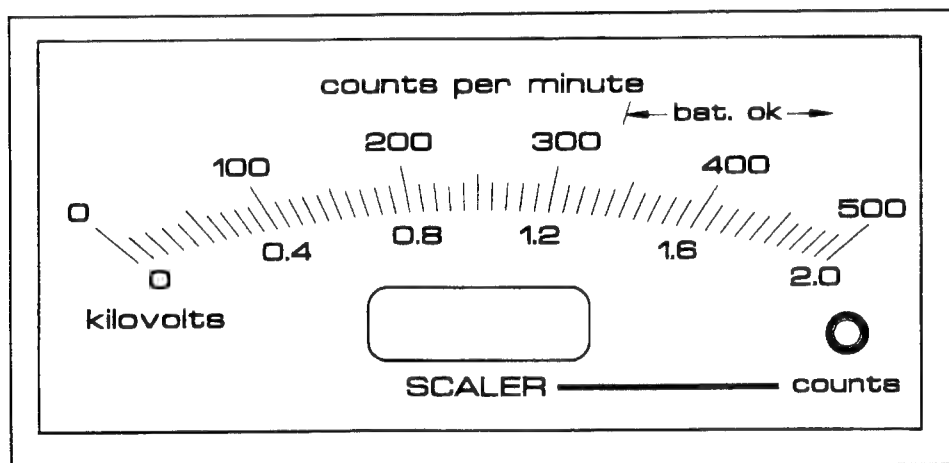


Figure 2  
Meter Scale

## 2.0 Battery Installation

The Analyst is delivered with a 9-volt Mallory MN 1604 battery, or equivalent. This section defines the procedures for replacement and testing of the battery.

Note that some instruments have a parallel-wired battery option. In this case, two batteries are wired into the circuit. Installing a second battery thus provides twice the operational hours. Only one battery is needed to power the instrument, however.

### 2.1 Procedure

1. Turn instrument off.
2. Open the pull catches at both ends of the case and separate the case bottom from the top.
3. Install the battery in the appropriate clip on the bottom circuit board, observing proper polarity. The spare battery clip is appropriately marked.
4. Replace the bottom part of the case, orienting the rubber pad under the battery; close the catches.

### 2.2 Battery Test

Turn control switch to the "bat." position; the meter reading should be within the "bat. ok" range. This test monitors the condition of the battery.

### 2.3 High Voltage Measurement

Turn control switch to the "HV" position. Detector high voltage is directly displayed on the lower meter scale.

## 3.0 Single Channel Analyzer (SCA) Operational Modes

The Analyst operates in three different counting modes, as determined by the setting of the analyzer switch on the top of the instrument (Figure 1).

### 1. Gross counting mode.

When the analyzer knob is set to "out", the ANALYST functions as a high-performance, linear pulse count-rate meter. The adjustable high voltage and lower level discriminator may be set for many types of GM probes, scintillation detectors, or proportional counters.

### 2. Window mode.

When the analyzer knob is set to "ch. 1", the ANALYST provides energy discrimination by accepting only those detector pulses within a certain range or window. This setting facilitates the measurement of certain low-energy nuclides while providing a substantial reduction in background counting rate.

"ch. 1" counts all pulses between the lower and upper level discriminators.

### 3. Higher energy mode.

A unique feature of the Bicron ANALYST is activated by setting the analyzer knob to "ch. 2". This mode provides a second region of interest above the analyzer window. For example, when used with Bicron Alpha/Beta discriminating probes, the analyzer measures beta in "ch.1", alpha in "ch.2", and both alpha and beta in "out".

"ch.2" counts all pulses above the upper-level discriminator.

#### 4.0 Setup

Initial control adjustments to the instrument are determined by the type of probe to be used. GM probes usually require only that the high voltage (Section 4.3 High Voltage Adjustment) be set at a specified value.

Scintillation probes require that counting rate plateau determination (Section 4.4 Counting Rate Plateau) and/or peak centering (Section 4.5 Peak Centering) be performed to find the proper high voltage setting.

Adjustment to the factory-set lower-level discriminator (Section 4.1 Lower Level Discriminator) and/or window width (Section 4.2 Window (Upper-Level Discriminator)) settings may have to be made to suit a specific surveying situation.

The controls for the high voltage adjustment, the lower-level discriminator setting, and the window width setting are easily accessible, internally mounted trimming potentiometers. Their locations are indicated on a label in the case bottom and in Figure 3.

##### 4.1 Lower-Level Discriminator

This setting determines the lower level of pulse heights that are counted by the instrument in the "ch. 1" and "out" modes. In conjunction with the high voltage adjustment control, this setting determines the lower-energy cutoff with scintillation probes.

The standard (factory) setting is 50 millivolts. This value can also be referred to as the instrument's input sensitivity. This provides sufficient sensitivity for all Bicorn GM and scintillation probes and is well above the electronic noise level. It is generally not necessary to change this setting.

Turning the control ("LLD" on Figure 3) clockwise raises the discrimination level (i.e., raises the low-energy cutoff), while turning it counterclockwise lowers this level. *NOTE: Do not turn the control too far counter-clockwise or electronic noise will be counted by the system.*

To set the lower-level discriminator:

1. Connect the positive lead of a voltmeter to the center wiper of LLD (R2, 5 Kohm pot).
2. Connect the negative lead to pin 6 of U1 (3302 IC).
3. Adjust LLD until the voltmeter reads 50 mV.

##### 4.2 Window (Upper-Level Discriminator)

This control varies the width of the window (i.e., the upper level of pulse heights which are counted by the instrument) in the "ch. 1" mode, and also functions as the discriminator for the low end of "ch. 2" mode.

The standard (factory) width is 300 mV, which gives an upper-level discriminator setting of 350 millivolts. Turning the control ("W" on Figure 3) clockwise widens the window; turning it counterclockwise narrows it. To set the SCA window width, proceed according to the following steps.

1. Connect the positive lead of a voltmeter to pin 6 of U1 (3302 IC).
2. Connect the negative lead to pin 4 of U1.
3. Adjust control "W" (R4, 5 Kohm pot) until the voltmeter reads 300 mV.

## 4.0 Setup (cont'd)

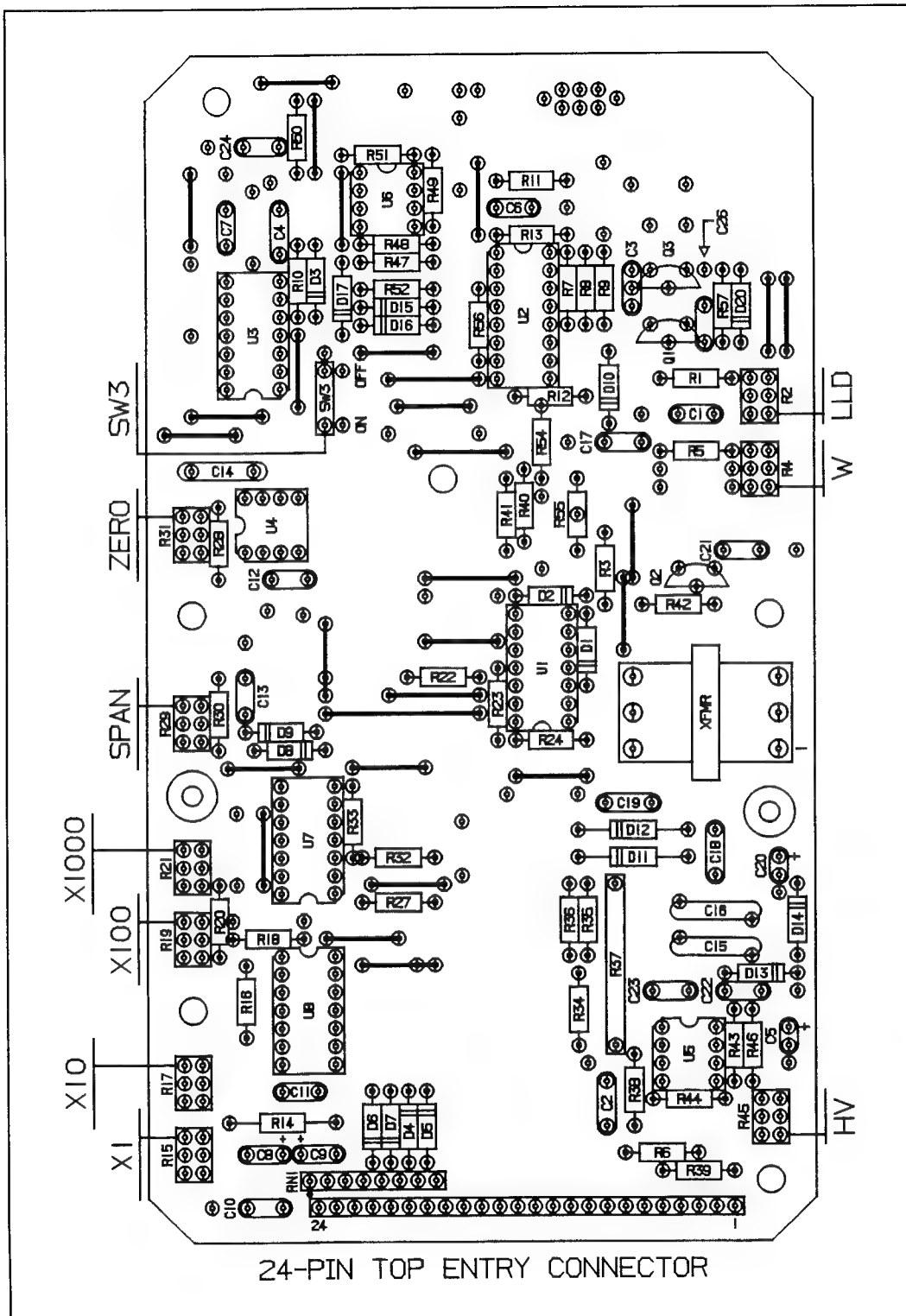


Figure 3  
Main Printed Circuit Board

#### 4.0 Setup (cont'd)

#### 4.3 High Voltage Adjustment

This control provides an easy adjustment to the detector high voltage. The actual high voltage setting is read on the meter scale when the selector switch is in the HV position (Section 2.3 High Voltage Measurement).

Clockwise rotation of this control ("HV" on Figure 3) increases the high voltage, while counterclockwise rotation decreases it. It may take a few seconds for the high voltage to decrease following a counter-clockwise adjustment.

The normal factory high voltage setting is 900 volts. Settings to suit a specific probe should be made when calibrating the probe.

*NOTE: A high voltage setting in excess of the maximum high voltage specified for the probe being used may cause damage to the probe! Please note this caution whenever adjusting the high voltage.*

#### 4.4 Counting Rate Plateau

Determination of the counting rate plateau must be done to set up the ANALYST for use in a "gross counting" mode with a NaI scintillation probe. (See Sections 3.0 Single Channel Analyzer Operational Modes and 8.2 NaI Scintillation Probes.) Proceed as follows to find the counting rate plateau:

1. Turn the analyzer switch to "out", and the response switch to "fast".
2. Place a small reference source of the type to be measured near the window of the probe in a fixed geometry.

3. Set the high voltage control ("HV" on Figure 3) fully counterclockwise.
4. With the instrument on one of its counting ranges, slowly increase the high voltage until counting begins.
5. Switch to "HV" and note the voltage.
6. Increase the high voltage by 100 volts.
7. Switch to an appropriate counting range and note the counting rate.
8. Repeating steps 5, 6, and 7 will yield data indicating a region where the counting rate remains relatively constant when the high voltage is varied by 50 volts in either direction. This is the counting rate plateau.
9. Once the counting rate plateau has been found, record the counting rate and the high voltage setting for future reference.

#### 4.5 Peak Centering

This technique is used to set up the ANALYST and a NaI scintillation probe for a surveying situation where energy discrimination or reduction in the effect of background is required. To peak center a desired energy band, do the following:

1. Check the high voltage setting.
2. Turn the analyzer switch to "ch. 1".
3. Place a small reference source, of the type to be measured, near the window of the probe, in a fixed geometry.
4. Switch to an appropriate counting range and adjust the high voltage to produce a low count rate.

**4.0 Setup (cont'd)****4.5 Peak Centering (cont'd)**

5. Slowly increase the high voltage until the count rate reaches a maximum and then begins to decrease.
6. Slowly reduce the high voltage until the maximum count rate is obtained.
7. Switch to HV, note the setting, and record it for future reference.

If the counting rate is substantially less in "ch. 1" than in the "out" position, it may be that the window setting is too narrow. To widen the window, turn the window potentiometer slightly clockwise (See Section 4.1 Lower-Level Discriminator.) and repeat the peak centering technique. Repeat this procedure as required.

The price paid for a wider window setting is a loss in discriminating ability. Adjacent energies from other radiation sources will enter into the total count rate observed. Thus, a compromise should be reached between counting efficiency and energy discrimination desired.

*Note: The high voltage settings determined in Section 4.4 Counting Rate Plateau and 4.5 Peak Centering for a particular probe and energy source will not change from use to use and, for that reason, should be recorded. Having a record of these settings simplifies setup the next time the probe is used to detect that same energy. Positions of the lower-level discriminator and window trim pot settings should also be recorded if they have been changed.*

**4.6 Alpha/Beta Probe Setup**

To set up the ANALYST with alpha/beta scintillation probes employing plastic or ZnS scintillators (such as Bicron's B1, B50, A1, A50, etc.), the high voltage must be adjusted to produce good counting efficiency. This adjustment is accomplished by following the counting rate plateau procedure (Section 4.4 Counting Rate Plateau).

However, a range setting in which the counting rate changes only slightly as the high voltage is varied may be found instead of a distinct counting rate plateau. Select a high voltage setting from within this range.

Note that the counting efficiency for the probe increases as the high voltage increases.

**4.7 Alpha/Beta Discrimination**

To set up the ANALYST for alpha/beta discrimination with Bicron AB probes such as the AB1 or AB50, do the following:

1. Turn the analyzer switch to "ch.1" and the response switch to "fast".
2. Place a small beta reference source near the probe window in a fixed geometry.
3. Select a high voltage setting that yields an appropriate counting efficiency (Section 4.6 Alpha/Beta Probe Set-up).
4. Switch to "ch.2" and turn the audio on.
5. Adjust the window so that minimal counting is observed in "ch. 2".
6. Note the high voltage and window settings for future reference.



#### 4.0 Setup (cont'd)

##### 4.8 Neutron Probe Setup

To set up the ANALYST with neutron scintillation probes (those that use plastic scintillators), do the following:

1. Turn the analyzer switch to "out", the response switch to "fast", and the audio on.
2. Adjust the high voltage to 1100V and switch to an appropriate counting range.
3. Place a  $^{60}\text{Co}$  reference source near the detector end of the probe in a fixed geometry. (The source may be placed against the end of the probe if necessary to obtain a convenient count rate.)
4. Adjust the high voltage (See Section 4.3 High Voltage Adjustment) downward until counting stops.
5. Exchange the  $^{60}\text{Co}$  source with a neutron reference source and observe that counting takes place.

*NOTE: If the count rate with the neutron source is considered too low to be convenient, the high voltage may be increased. This increase, however, will result in a gamma contribution to the count rate that increases as the high voltage increases.*

##### 5.0 Digital Scaler

The ANALYST with digital scaler provides a six-digit count totalizer with three available count time periods: 0.1, 1, and 10 minutes. The digital scaler features a crystal-controlled timebase for greater accuracy.

The count time period is user selectable via an internally mounted three-position slide switch (SW102) located on the digital scaler-printed circuit board. *With the instrument turned off*, slide the switch to the count time period desired, as indicated on the circuit board. This should be done while the unit is turned off.

To use the digital scaler, press the "count" pushbutton on the case top. The "count" light will illuminate, indicating that a count is in progress. When the light turns off, the count time has been completed.

Once a count has been started, the "count" pushbutton is electronically locked out to prevent accidental restarting. If you wish to reset the scaler once a count period has begun, simply turn the instrument off for a few seconds, and then turn it back on.

## 6.0 Audio

An internal speaker produces an audible click for each detector pulse. This speaker is controlled by a panel-mounted on/off switch labeled "audio" (Figure 1).

An audible alarm will sound when the meter is approximately 30% or more above full scale on any range. This over-range alarm can be disabled by turning off an internal on/off switch located on the main circuit board.

The over-range alarm will function only when the panel-mounted "audio" control is in the off position, and the internal switch is on. When the speaker control is in the on position, the over-range alarm is disabled.

## 7.0 Selectable Response Time

In addition to the built-in circuitry that optimizes response time for each range, a front-panel switch labelled "response fast - slow" (Figure 1) may be used to tailor response time to the survey situation.

## 8.0 Operation

After the setup is completed, proceed as follows to make a radiation measurement:

1. Check the high voltage setting (Section 2.3 High Voltage Measurement) and connect the probe.
2. Select the appropriate response time (Section 7.0 Selectable Response Time), analyzer mode (Section 3.0 Single Channel Analyzer), audio (Section 6.0 Audio) and counting range settings.
3. Perform the survey, making sure to multiply the meter reading by the counting range setting to obtain the reading in counts per minute.

See the sections noted and the following sections on the use of various probes for more detailed instructions.

### 8.1 GM Probes

To use the ANALYST with a GM probe, do the following:

1. Determine that the high voltage setting is appropriate for the probe in use. If you don't know this setting, find the counting rate plateau (Section 4.4 Counting Rate Plateau). The LLD control should also be set appropriately.
2. Turn the analyzer switch to "out" (Section 3.0 Single Channel Analyzer Operational Modes) and connect the probe.
3. Select the audio and response settings deemed appropriate (Sections 6.0 Audio and 7.0 Selectable Response Time).
4. Select a counting range. Any of the four ranges may be used.

### 8.2 NaI Scintillation Probes

To provide energy discrimination or background reduction, use the ANALYST with a NaI scintillation probe as follows:

1. Determine that the high voltage, LLD, and Window settings are appropriate for the probe in use. If these are not known, follow the peak centering procedure (Section 4.5 Peak Centering).
2. Turn the analyzer switch to "ch.1" to detect the energy setup within the window, "ch. 2" to detect energies above the window, and "out" to detect energies in both regions (See Section 3.0 Single Channel Analyzer Operational Modes).
3. Connect the probe and select the audio and response settings deemed appropriate.
4. Select a counting range. Any of the four ranges may be used.

### 8.3 G1LE Probe

When the ANALYST is used with the Bicorn G1LE scintillation probe,  $^{125}\text{I}$  is set up in the analyzer window (Section 4.5 Peak Centering). The "ch.1" analyzer mode is used for making radiation measurements.

### 8.4 G5 FIDLER Probe

Use the ANALYST in the "ch.1" mode following peak centering (Section 4.5 Peak Centering) with a check source representative of the energy range (isotope) of interest.

### 8.5 Wound Probe

Use the ANALYST in the "ch. 1" mode after finding a count-rate plateau (Section 4.4 Counting Rate Plateau) with a  $^{137}\text{Cs}$  check source.

**8.0 Operation (cont'd)****8.6 Alpha/Beta Scintillation Probes**

To use the ANALYST with an alpha or beta scintillation probe, proceed as follows:

1. Determine that the high voltage setting is appropriate for the probe in use. If this setting is not known, see Section 4.6 Alpha/Beta Probe Setup.
2. Turn the analyzer switch to "out" and connect the probe.
3. Select the audio and response settings deemed appropriate.
4. Select a counting range. Any of the four ranges may be used.

**8.7 Neutron Scintillation Probes**

To use the ANALYST with these probes (such as Bicron's FN-1, TN-1, etc.), do the following:

1. Determine that the high voltage setting is appropriate for the probe in use. If this setting is not known, see Section 4.8 Neutron Probe Setup.
2. Turn the analyzer switch to "out" and connect the probe.
3. Select the audio and response settings deemed appropriate.
4. Select a counting range. Any of the four ranges may be used.

**8.8 AB Probes**

When the ANALYST is used with a Bicron AB alpha/beta discriminating probe, a beta radiation source is set up in the analyzer window (Section 4.7 Alpha/Beta Discrimination). With this setting, betas are detected when "ch. 1" is selected; alphas when "ch. 2" is selected; and alphas and betas combined when "out" is selected.

## 9.0 Circuit Description

The electronic circuitry in the Bicron ANALYST (digital scaler version) is contained on four interconnected printed circuit boards. Modern, solid-state, integrated circuitry is used throughout. The major components are the following:

1. A high-voltage power supply. This is a feedback-regulated, electronically stabilized supply for the detector potential. Additional circuitry provides high voltage readout on the meter scale.
2. A count-rate meter. A linear charge pump ratemeter converts the detector pulses to a count-rate reading on the calibrated meter scale. The circuitry includes a unique resolving time compensation technique to provide linear response over the full range with scintillation detectors (but not GM probes), automatic and manual time constant selection, and temperature compensation.
3. Audio circuitry for individual pulse counting and overrange alarm.
4. Single-channel pulse-height analysis circuitry with three operating modes.
5. Digital scaler circuitry.

## 10.0 Calibration

Individual calibration controls are provided for each range. The locations of these controls are shown on a label in the case bottom.

The ANALYST is electronically calibrated in cpm using a variable frequency pulse generator. A detailed calibration procedure is part of the QC Acceptance Procedure found elsewhere in this manual.

Peak centering for  $^{125}\text{I}$  with the G1LE probe (or for other isotopes with other NaI scintillation probes) is available from the factory.

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## Appendix A

**Bicron QC Acceptance Procedure Number 1063930****Model: ANALYST (Digital Scaler Version)**

1. Perform a visual inspection of the finished product.

See Figure 3 for location of all Circuit Board components not labeled on the board.

2. Remove all 9V batteries and connect a  $9.30V \pm .05V$  power source across the main battery terminals on the battery board. Perform the following calibrations:

- a. Turn the control switch OFF. Mechanically zero the meter via the rear zero adjustment screw on the meter barrel.
- b. Turn the control switch to X1000. Check the +5V supply at Pin 1 of U6 (ICL 7663). The reading should be  $5VDC \pm 10\%$ .
- c. Leave the control switch set at X1000 and connect a voltmeter between pins 1 (ground) and 15 of the 24-pin connector. Adjust "ZERO" (R31, 50 kohm zero pot) until the voltmeter reads 1 mVDC  $\pm 2.5mV/-1mV$ .
- d. Turn the control switch to "HV" and connect a high-voltage measuring device with an impedance no less than 1000 megohms to the probe connector center pin. Adjust the high voltage supply via "HV" (R45, 50 Kohm pot) to  $+1000 VDC \pm 3\%$ .

- e. Leave the control switch set to "HV" and adjust "SPAN" (R29, 500 ohm span pot) until the meter reads 1.0KV. To test linearity, increase HV to +1600V. The meter should read  $1.6KV \pm 5\%$ . Decrease high voltage to +400 V. The meter should read  $0.4KV \pm 5\%$ .

3. Perform a CPM calibration, as follows:

- a. Turn the analyzer switch to "out" and the control switch to X1000.
- b. Connect a variable frequency pulse generator (amplitude of  $-1.5V \pm 10\%$  with pulse width of 10  $\mu sec$ ) and adjust the frequency to the value (see Table T-1) required to calibrate the unit at 80% of full scale on the meter.
- c. Adjust "X1000" (R21, 5 Kohm calibration pot) until the meter reads 80% of full scale.
- d. Readjust the frequency to the value to calibrate at 20% of full scale (see Table T-1).
- e. Note the meter readings from steps 3.c. and 3.d. on a Certificate of Calibration.
- f. Similarly, calibrate the X100 range using "X100" (R19, 50 Kohm calibration pot), the X10 range using "X10" (R17, 500 Kohm calibration pot), and the X1 range using "X1" (R15, 5 megohm calibration pot).

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## Appendix A (cont'd)

- g. Leave the pulse generator connected when calibration is complete.
  4. Mark all trimpot bodies to show the general position of the adjustment screws after calibration.
  5. Turn the response switch to "fast" and the control switch to "X1000". Vary the frequency of the pulse generator and switch between "fast" and "slow" to check the operation of the response switch. Do the same on "X100", "X10" and "X1". Leave the pulse generator connected.
  6. Test the audio:
    - a. Turn the audio switch "ON" and ensure that it functions properly on all four counting ranges, using the pulse generator. Also, check that the audio remains silent when the selector switch is on "bat." and "HV."
    - b. Turn the audio switch "OFF" and the alarm on/off switch "SW3" mounted on the main PC board to "ON". Drive the meter well beyond full scale with the pulse generator to ensure that a continuous tone is heard. Do this on all four ranges.
  7. Test for proper operation of the anti-saturation circuit:
    - a. Turn the control switch to "HV" and adjust the high voltage to +900 VDC via "HV" (R45, 50 Kohm pot).
    - b. Turn the control switch to "X1000" and connect a 30-megohm resistor across the probe connector (i.e., from the +900 VDC supply to ground). The meter should peg beyond full scale.
    - c. Remove the 30-megohm resistor and connect a 50-megohm resistor in its place. The meter should remain at zero. Remove the resistor.
    - d. Leave the high voltage set at +900 VDC unless otherwise specified by customer.
  8. Test the analyzer section for proper operation:
    - a. Set the Lower Level discriminator (LLD): Connect a voltmeter between the center wiper of "LLD" (R2, 5-kohm pot) and pin 6 of U1. Adjust "LLD" to 50 mV.
    - b. Set the Window width ("W"): Connect a voltmeter between the center wiper of "W" (R4, 5 kohm pot) and pin 6 of UI. Adjust "W" to 350 mV.
    - c. Set the Analyst Control Switch to the "X100" position and the Analyzer Switch to the "out" position.
    - d. Connect an Eberline Mini Pulser between test point 2 (pin 5 of the 24-pin connector) and ground (pin 1 of the 24-pin connector).
    - e. Set the Pulser Frequency Base Switch to 16, the Multiplier Switch to 1k, the Variable Frequency Dial to Cal, the Amplitude Dial to 3 v, and the Amplitude Fine Dial fully counterclockwise.



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## Appendix A (cont'd)

- f. Adjust the Amplitude Fine Dial until you see an "on-scale" reading on the Analyst meter. This reading becomes the "Reference Reading." Turn the Analyzer Switch to the "ch 1" position; the meter reading should not change. Turn the Analyzer Switch to the "ch 2" position; the meter should read zero.
- g. Adjust the Amplitude Fine Dial to the 3 o'clock position. With the Analyzer Switch in the "ch 2" position the meter reading should be equal to the Reference Reading. Turn the Analyzer Switch to the "out" position, the meter reading should remain the same. Turn the Analyzer Switch to the "ch 1" position; the meter should read zero.
9. Remove all test equipment. Turn the instrument off and install a new +9V battery in the appropriate battery holder (either holder may be used when holders are parallel-wired).
10. Attach a probe to the instrument, observing the proper high voltage precautions. Place the probe near an appropriate check source and turn the selector switch to each of the four ranges in turn. A meter reading should be obtained for each range. Leave the probe connected to the instrument.
11. Connect a frequency counter to pin 11 of U101. The frequency should be 32.768 kHz  $\pm 0.1\%$ . Set the digital scaler for a 0.1-minute count time. Turn the control switch to one of the four counting ranges. Press the "count" pushbutton. Time the count period. It should be 0.1 minutes.  
Set the digital scaler for a 1-minute count time. Press the "count" pushbutton. Time the count period. It should be 1 minute. Compare the CPM reading on the analog meter with the digital scaler total count. They should be the same.
12. Turn the instrument off and disconnect the probe. Complete, date, and sign a Certificate of Calibration.

Table T-1

Range	Pulse Generator Output (HZ)	Actual cpm	Acceptable Meter Reading (cpm)
X1000 (80%)	6060	400,000	360,000 - 440,000
X1000 (20%)	1625	100,000	90,000 - 110,000
X100 (80%)	660	40,000	36,000 - 44,000
X100 (20%)	166	10,000	9,000 - 11,000
X10 (80%)	66.7	4,000	3,600 - 4,400
X10 (20%)	16.7	1,000	900 - 1100
X1 (80%)	6.7	400	360 - 440
X1 (20%)	1.7	100	90 - 110

Note: The values in this table may not correspond to those for other Bicron or competitive models.

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## Appendix B

Spare Parts List 1063910  
Bicron Analyst W/Digital Scaler

Schematic Symbol	Description	Part No.
	Main PC Board Assembly	1003010
C1, C22	Capacitor, 0.1 $\mu$ F, Film	9211041
C2, C18, C19	Capacitor, 0.001 $\mu$ F, 3 kV cer.	9201022
C3	Capacitor, 0.001 $\mu$ F, Film	9211021
C4	Capacitor, 150 pF, Ceramic	9201511
C5, C20	Capacitor, 33 $\mu$ F, 16 V tan.	9233362
C6, C7, C23	Capacitor, 0.01 $\mu$ F, Film	9211031
C8	Capacitor, 2.2 $\mu$ F, 16 V tan.	9232251
C9	Capacitor, 1.0 $\mu$ F, 35 V tan.	9231051
C10, C13, C17	Capacitor, 0.22 $\mu$ F, Film	9212241
C11, C12, C21, C24	Capacitor, 0.047 $\mu$ F, Film	9214731
C14	Capacitor, 200 pF, N750 cer.	9202011
C15, C16	Capacitor, 0.01 $\mu$ F, 3 kV cer.	9201032
C26	Capacitor, 0.0033 $\mu$ F, Film	9213321
D1-D10, D13-D17, D20	Diode, 1N4148	9600004
D11, D12	Rectifier, 2kV PIV	9600001
Q1	Transistor, 2N4124	9610001
Q2	Transistor, 2N5210	9610005
Q3	Transistor, 2N4126	9610002
R1, R9, R20	Resistor, 10k, 1/4w, 1%	8510024
R2, R4, R21	Trimpot, 5k,	9395021
R3, R6, R10, R56, R57	Resistor, 10K, 1/4w, 5%	8110024
R5, R27	Resistor, 4.99k, 1/4w, 1%	8549914
R7, R8	Resistor, 4.7k, 1/4w, 5%	8147014
R11, R12, R22, R54	Resistor, 100k, 1/4w, 5%	8110034
R13, R50	Resistor, 274k, 1/4w, 1%	8527434
R14	Resistor, 10 meg, 1/4w, 1%	8510051
R15	Trimpot, 5 meg	9395051
R16, R32	Resistor, 1 meg, 1/4w, 1%	8510044
R17	Trimpot, 500k,	9395041
R18, R48	Resistor, 100k, 1/4w, 1%	8510034
R19, R31, R45	Trimpot, 50k	9395031
R23, R34, R35, R36, R47, R51, R52	Resistor, 1 meg, 1/4w, 5%	8110044
R24, R44	Resistor, 470k, 1/4w, 5%	8147034
R28	Resistor, 82.5k, 1/4w, 1%	8582524
R29	Trimpot, 500 ohm	9395011
R30	Resistor, 249 ohm, 1/4w, 1%	8524904
R33	Resistor, 11k, 1/4w, 1%	8511024
R37	Resistor, 1000 meg, 1%	8810071
R38	Resistor, 499k, 1/4w, 1%	8549934

## Appendix B (cont'd)

**Spare Parts List**  
**Bicron Analyst W/Digital Scaler**

Schematic Symbol	Description	Part No.
R39	Resistor, 49.9k, 1/4w, 1%	8549924
R40, R55	Resistor, 47k, 1/4w, 5%	8147024
R41	Resistor, 150k, 1/4w, 5%	8115034
R42, R43	Resistor, 2.7k, 1/4w, 5%	8127014
R46	Resistor, 200k, 1/4w, 1%	8520034
R49	Resistor, 23.7k, 1/4w, 1%	8523724
RN1	Res. Network, 7 x 220k	8822031
SW3	Switch, Slide, SPST	9550001
U1	Int. Ckt., MC3302PDS	9640002
U2	Int. Ckt., MC14538BCPDS	9650004
U3	Int. Ckt., MC14093BCPDS	9650001
U4, U5	Int. Ckt., CA5160BEX	9640001
U6	Int. Ckt., ICL7663CPA	9640003
U7, U8	Int. Ckt., CD4016BEX	9650002
XFMR	Transformer, M8149	9500001
	Connector, 24-pin	9780001
	Switch PC Board Assembly	1003020
R26	Resistor, 681 ohm, 1/4w, 1%	8568104
SW1	Switch, Rotary, 3 pos.	9560002
SW2, SW4	Switch, Rotary, 2 pos.	9560003
SW5	Switch, Rotary, 2-7 pos.	9560001
	Sounder	9720001
	Header, 24-pin	9780002
	Battery PC Board Subassembly (w/out Parallel-Wired Option, 9420001)	9420002
	Case Top Ass'y w/ Digital Scaler (w/out Scaler Option, 1003140)	1063140
SW101	Switch, Pushbutton (w/out Scaler Option, not required)	9550008
	Rubber Boot (w/out Scaler Option, not required)	9960018
	Handle	9710002
	Meter (w/out Scaler Option, 9400005)	9400047
	Meter Window	9400011
	Meter Support Bracket Ass'y	9850014
	MHV Connector	9782001
	Probe Clip	9460004

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## Appendix B (cont'd)

**Spare Parts List**  
**Bicron Analyst W/Digital Scaler**

Schematic Symbol	Description	Part No.
	Digital Scaler PC Board Assembly (w/out Scaler Option, not required)	9420013
C101, C102	Capacitor, 22 pF, Ceramic	9202201
C103	Capacitor, 33 $\mu$ F, 16 V tan.	9233362
C104	Capacitor, 0.01 $\mu$ F, Film	9211031
C105	Capacitor, 0.047 $\mu$ F, Film	9214731
D102, D103	Diode, Zener, 1N5231B	9600011
R101	Resistor, 10 meg, 1/4w, 5%	8110054
R102	Resistor, 470k, 1/4w, 5%	8147034
R103, R105	Resistor, 100k, 1/4w, 5%	8110034
R104, R107, R108	Resistor, 1k, 1/4w, 5%	8110014
R106	Resistor, 3.3 meg, 1/4w, 5%	8133044
R109	Resistor, 200 ohm, 1/4w, 5%	8120004
R110	Resistor, 4.7k, 1/4w, 5%	8147014
SW102	Switch, Slide, 3 pos.	9550010
U101	Int. Ckt., MC14011BCPDS	9650029
U102, U103	Int. Ckt., MC74HC4040NDS	9650009
U104	Int. Ckt., MC14093BCPDS	9650001
U105	Int. Ckt., ICM7240IPE	9650021
XTAL	Crystal, 32.768 kHz	9729002
	6-Digit LCD Counter/Display Module	9685001
	Miscellaneous	
BT1, BT2	Battery, 9V alkaline, MN1604	9750001
	Cable, Probe, MHV-MHV, 36-inch	9801001
	Knob, Round, w/pointer	9770001
	Knob, Function	9770003
	Manual, Instruction	1063900
	Spare Parts List	1063910
	Schematic Circuit Diagram	1063920
	QC Acceptance Procedure	1063930

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**Appendix C**

The drawings listed below follow this page.

1003920	Schematic Circuit Diagram
9700243	Main Printed Circuit Board Assembly
9700244	Switch Printed Circuit Board Assembly
9700225	Schematic, Digital Scaler Option
9700226	Digital Scaler Option Printed Circuit Board Assembly

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